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REPORT OF ENVIRONMENTAL OPERATION

TCB-61-045-EO

WILLOW FREEZE

DECEMBER 1961

UNITED STATES ARMY TRANSPORTATION BOARD
Fort Eustis, Virginia

6550-61

PREFACE

This paper is the final report for U S Army Transportation Board Project TCB-61-045-EO, WILLOW FREEZE. It covers the role of the Transportation Corps during the USARAL winter maneuver of 1960-61 and contains evaluations of certain vehicular equipment employed by the Transportation Board for logistical support of the two battle groups participating in the exercise.

This report has been prepared and published by the U S Army Transportation Board for the information and guidance of recipients and does not necessarily reflect the official opinion of the Chief of Transportation or the Department of the Army.

ROBERT B HARRISON
Colonel, TC
President

Fort Eustis, Virginia
December, 1961

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I. INTRODUCTION

A. General. This report is a record of the Transportation Corps role during Exercise WILLOW FREEZE. The exercise was a semicontrolled maneuver conducted in five phases in Alaska during the winter of 1960-61. The fourth phase was a field exercise played from 9 through 17 February 1961. The maneuver was held in the Copper River Basin in an area approximately 75 miles long from north to south and 25 miles wide from east to west. The terrain is adverse, varying from low mountains in the north to flat, rolling terrain in the south. The climate is subarctic. Temperature in the maneuver area ranged from -37° to +18° F. The snow cover varied from 15 inches in the south to 4 to 5 feet in the north, and was approximately 2 feet deep in the center of the maneuver area.

B. Logistical Organization. One objective of Exercise WILLOW FREEZE was the determination of the logistical organization required to support independent and widely dispersed forces operating in an undeveloped northern area during the winter. The concept that was evaluated during this exercise is known as general support organization. This organization is planned on an area basis: general support bases are established as needed to support the direct support groups that support the task forces. Task forces range in size from independent battle groups to divisions.

C. Transportation Corps Mission. The mission of the Transportation Corps was to evaluate the equipment discussed in sec. II, par. C and manner of employment as used in the logistical support of two battle groups operating over adverse terrain in a subarctic region in the wintertime. Annex A contains the operation order.

II. SUMMARY

A. General. Exercise WILLOW FREEZE involved two reinforced battle groups, U. S. Forces and Aggressor Forces, operating independently. Each battle group was supported by a direct support group; these groups were supported by a general support base (Gulkana General Support Base). The direct support groups were established to reinforce the battle group field trains with supplies and limited maintenance. The general support base (GSB) had operational control over the direct support group (DSG) which supported the U. S. Forces; the commanding officer of the Aggressor Forces exercised operational control over the direct support group which supported him.

B. U. S. Army Transportation Board (USATCB) Task Detachment Logistical Support. USATCB support consisted of providing the two battle groups with high-capacity, off-road equipment. The USATCB Task Detachment was divided into three elements with equipment allocated as follows.

1. General Support Base. The Overland Train, Mark I (Cargo Transporter, Off-Road Train: High Mobility, 45-Ton Capacity) was under the operational control of Gulkana General Support Base during the entire exercise. Initially the train was used in the line of communication between the Gulkana General Support Base and the U. S. Forces' direct support group. It did not prove feasible to operate it over the type of terrain in which the U. S. Forces were located without a semiprepared trail.* Consequently, on the fifth day of the exercise, the employment of the train was changed, and it was used to provide logistical support between the Gulkana General Support Base and the Aggressor Forces' battle group.

2. U. S. Forces.

a. Cargo Transporter, Off-Road, Large Wheel, 10-Ton, 4-Wheel, M1 3

b. Transporter, Liquid, Rolling Wheel Type, 1,000-Gallon, M1 (RLT) 5

c. Tractor, Cargo (M8A2) 3

d. Wagner 4-Track Transporter. 1

3. Aggressor Forces.

a. Nodwell Carrier RN 110 5

b. Cargo Transporter, Off-Road, Large Wheel, 10-Ton, 4-Wheel, M1 2

c. Rolli-Trailer. 1

d. RLT, M1. 5
(These RLT's were obtained from the Aggressor's battle group field trains.)

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* In this report a semiprepared trail is used to mean a trail that has been broken by a bulldozer. In the type of terrain found in the maneuver area, a semiprepared trail can be traversed by tracked vehicles, but not by standard wheeled vehicles. Wheeled vehicles require a prepared trail.

C. Performance of Equipment.

1. Overland Train, Mark I. The train was unloaded and assembled at Palmer, Alaska. Movement from Palmer to Gulkana--a distance of 143 miles--was over a standard, two-lane highway. The transit was successful although the size of the train necessitated bypassing one narrow bridge. Some parts of this hard-surfaced road were covered with ice and snow. The first 73 miles had a number of relatively sharp curves and some inclines of approximately 8 percent; the remainder of the road was flat with gentle, rolling slopes. The train had adequate power and traction to move over this road without difficulty at an average speed of 8 miles per hour. The fuel consumption rate was 1.5 miles per gallon. This was an excellent performance for a cargo carrier of such size and weight.

During the initial phase of the maneuver, the train had to break its own trail through a scrub forest, and as a result the front section of the power car and one of the powered cargo trailers were damaged slightly. Two tires were punctured by the metallic-like, splintered stumps of the frozen trees pushed over by the train. The resulting difficulties demonstrated that successful operation of the train over such terrain requires a semiprepared trail. In the latter phase of the maneuver the train was operated 9.5 miles over a trail prepared by an engineer unit, using bulldozers. After one bulldozer broke down and another bogged in the muskeg, the train traveled 3.5 miles farther while breaking its own trail. At this point, a third tire was punctured by a frozen stump. During the time required to change the wheel assembly (rim and tire), the exercise was concluded and orders were received to return the train to Mile 160, Richardson Highway.

The major problem encountered with the train was punctured tires. This was the result of the type of tires used and of operating the train over totally unprepared routes. The tires were only 10-ply and proved unsatisfactory for off-road use over the terrain encountered in the maneuver area. All of the punctures occurred on the power car: two simultaneously, one on the right rear and one on the right front; later the left rear tire was punctured. Since the train was not equipped with a spare wheel assembly (rim and tire), valuable time was lost while waiting for wheel assemblies to be brought from the general support base. After the spare wheel assemblies were mounted, it was observed that there was no clearance between the frame of the power car and the tires. This caused further delay while the new wheel assemblies were exchanged with old ones on a powered cargo trailer. The new wheel assemblies performed satisfactorily on the powered cargo trailer. The lack of a lifting device on the front section of the power car complicated the changing of the front wheel assembly and required the use of a field expedient.

Previous operating experience showed that the wheel motors were apt to overheat in temperatures above +40° F. This tendency was watched closely, both on the movement to the maneuver area and during the maneuver; no overheating occurred.

The electrical braking system on the powered cargo trailers locks automatically when the power car is immobilized: immobilization of the power car prevents the exciting of the braking system. The braking system can be released manually, but it is a tedious and time-consuming task. This characteristic could seriously affect the accomplishment of a mission.

The capability of the power car and the capacity of the 15-ton powered cargo trailers were tested, to the extreme in some instances, and proved quite satisfactory. The train successfully negotiated inclines of 50 percent and side slopes of 18 percent.

The performance of the Overland Train, Mark I during this exercise demonstrated that it provides an excellent means of cross-country logistical support if operated over a semiprepared trail. Its usefulness and percent of availability would be appreciably increased by modifying it as detailed in section IV and making field maintenance immediately available.

2. Cargo Transporter, M1. The limited use made of these trailers precluded comprehensive evaluation. Forty miles was the greatest distance any one of these trailers was towed. Operation demonstrated that the tongue was weak and the turning radius too great. Further evaluation is necessary to determine the capability of this trailer.

3. Rolling Liquid Transporter (RLT), M1. The Rolling Liquid Transporter, M1, is a reliable and excellent means of moving bulk fuel over adverse terrain. No punctures or mechanical failures occurred during the exercise although the transporters were towed over unimproved roads and across country. Only minimum maintenance was required; availability was 100 percent. The refueling of vehicles is often delayed because fuel can be dispensed from only one cell of the RLT at the time. The feasibility of dispensing fuel from both cells simultaneously should be investigated.

4. Rolli-Trailer. The tongue of this vehicle should be lengthened to allow its prime mover a greater turning radius. The restricted use made of the vehicle prevented adequate evaluation.

5. Nodwell Carrier RN 110. The Nodwell Carrier proved to be a very capable and versatile vehicle. During this exercise it was used to provide close-in logistical support to a battle group. Its overall performance

indicated that it is suitable for use in a tactical situation in a subarctic region. The performance of this vehicle during this exercise was published as a separate report. *

6. Wagner 4-Track Transporter. Evaluation of this vehicle was the responsibility of United States Army, Alaska.

D. Divisions of Report. A fuller account of this exercise is given in section V. Annex A is the operation order; annex B shows daily temperature range during the exercise; annex C describes the performance of the Overland Train in detail; references are listed in annex D.

III. CONCLUSIONS

A. Overland Train, Mark I.

1. Without a semiprepared trail and equipped with 10-ply tires, the train is not suited for operation over adverse terrain such as that encountered in the maneuver area.

2. The train was not employed in a manner which permitted a fair or conclusive test of its capability.

3. The train has sufficient power and traction to negotiate the slopes encountered in the maneuver area (50 percent inclines, 18 percent slide slopes).

B. Cargo Transporter, M1. These transporters were never fully committed; therefore, a thorough evaluation was not possible. However, the limited use made of them indicated that they may prove useful in off-road operations.

C. Rolling Liquid Transporter, M1.

1. The RLT proved to be most capable and satisfactory.

2. It provides an easy method of moving bulk fuel forward in areas inaccessible to wheeled tankers.

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* "Final Report, Nodwell Carrier RN 110, Phase I: Subarctic Evaluation, 1961," U. S. Army Transportation Board, Fort Eustis, Virginia.

3. On-vehicle materiel permits the dispensing of fuel from only one cell at a time.

D. Rolli-Trailer. The limited use made of the Rolli-Trailer did not permit adequate evaluation.

IV. RECOMMENDATIONS

A. Overland Train, Mark I.

1. The train be equipped with metal-reinforced tires or tires of more than 10-ply.

2. A lifting device be installed on the front section of the power car to facilitate changing the front wheel assembly in the field.

3. A tire repair kit be provided as on-vehicle materiel so that small tire punctures may be repaired in the field without removing the wheel assembly or separating the tire from the rim.

4. A spare wheel assembly rack be installed on the train.

5. A simple and practical method of releasing the electric braking system be installed on the powered cargo trailers to facilitate moving them with prime movers other than the power car.

6. The bumper on the power car be extended to protect the front section and to help prepare a trail.

7. Field maintenance should be immediately available regardless of the train's location.

8. A mobile service unit be designed and procured. This unit should be equipped with a crane having a 7- to 8-ton lifting capacity at a 10-foot radius and a blade capable of preparing a trail suitable for any large off-road vehicle or train.

B. Cargo Transporter, M1.

1. The tongue be strengthened.

2. The turning radius be decreased.

3. Metal-reinforced tires be used.

4. Be modified as described above and further evaluated.

C. Rolling Liquid Transporter, M1.

1. The feasibility of dispensing fuel from both cells simultaneously be investigated.

2. All RLT personnel be thoroughly trained in its operation and maintenance.

D. Rolli-Trailer.

1. The tongue be lengthened to give the prime mover a greater turning radius.

2. Be further evaluated over adverse terrain.

V. DISCUSSION

A. Maneuver Area (figs. 1 and 2). The maneuver area covered about 1,875 square miles, extending 75 miles from north to south and 25 miles from east to west. It is bordered on the south by the Glenn Highway, on the east by the Richardson Highway, on the north by the Denali Highway, and on the west by a line generally following the Maclaren River, Moose Creek, the eastern shore of Lake Louise, and the Lake Louise Road. The total distance from Anchorage to the Gulkana General Support Base via the Glenn Highway is 191 miles.

In the southern part of the maneuver area, the land varies from very flat to gently rolling terrain with numerous ponds and lakes. Characterized by a series of rounded knobs, the ridges that form the foothills of the Alaska Range extend into the northern part of the maneuver area. Vegetation varies from high forest, consisting of white spruce 40 to 80 feet tall, to the tundra vegetation of the higher slopes of the northern ridges. The predominant vegetation in the southern lowland is brush and low forest, trees 20 to 40 feet high and brush 5 to 20 feet high. The north portion is characterized by brush, consisting of dwarf birch and willow 2 to 8 feet tall. The muskeg areas occurring along flat-bottom depressions and drainage ways have brush 2 to 5 feet high and a thick layer of spongy moss, sedges, and cotton grass covering deposits of peat. Roads are practically nonexistent. All movement in the area was across country: some movement was over semiprepared trails, some over totally unprepared routes.

B. Weather. For the greater part of the maneuver period, the weather was clear and cold. The ambient temperature ranged from +18° to approximately -37° F. Daily temperature ranges are given in annex B. At the beginning and again near the end of the exercise there were heavy snowfalls.

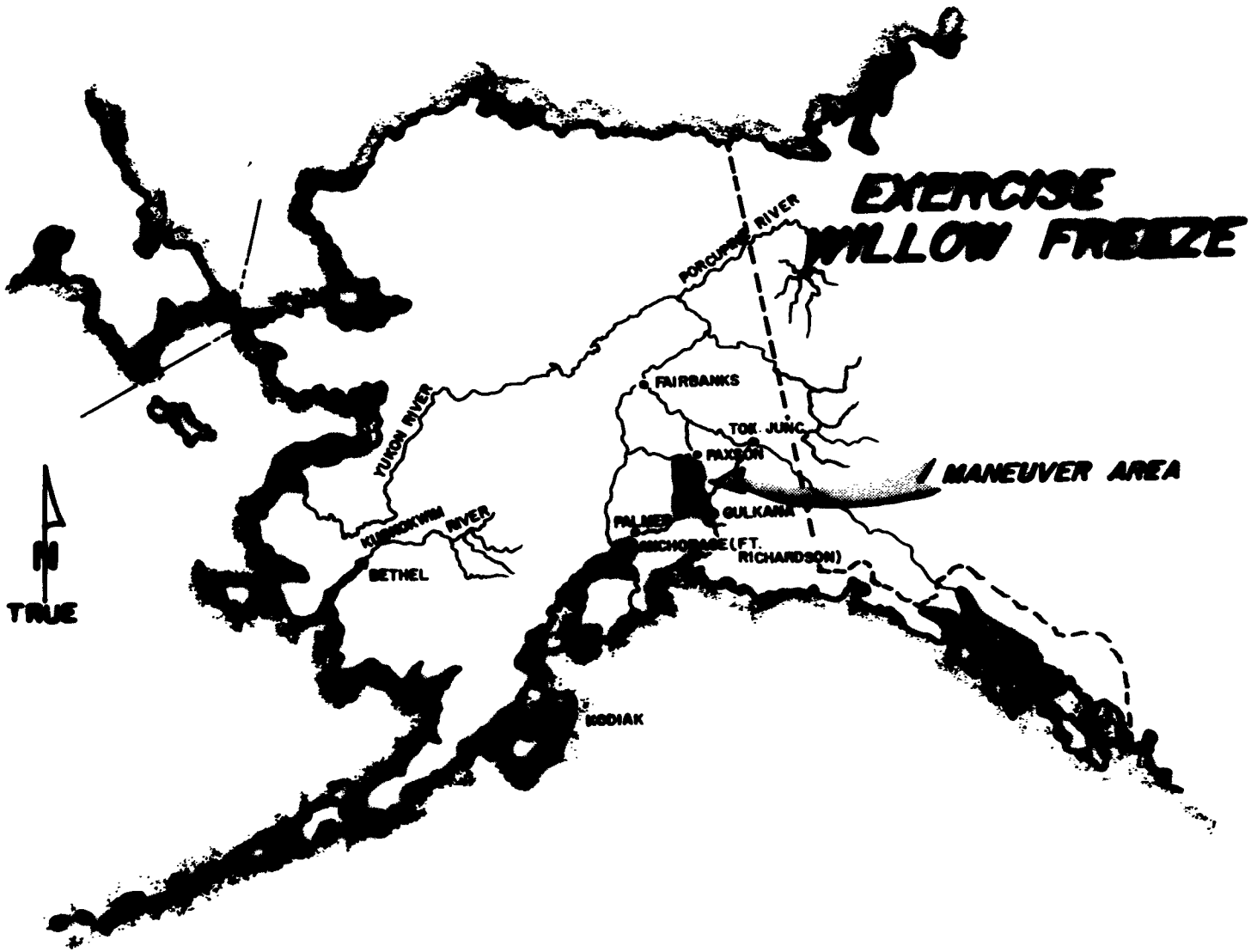

Figure 1. Exercise WILLOW FREEZE maneuver area.

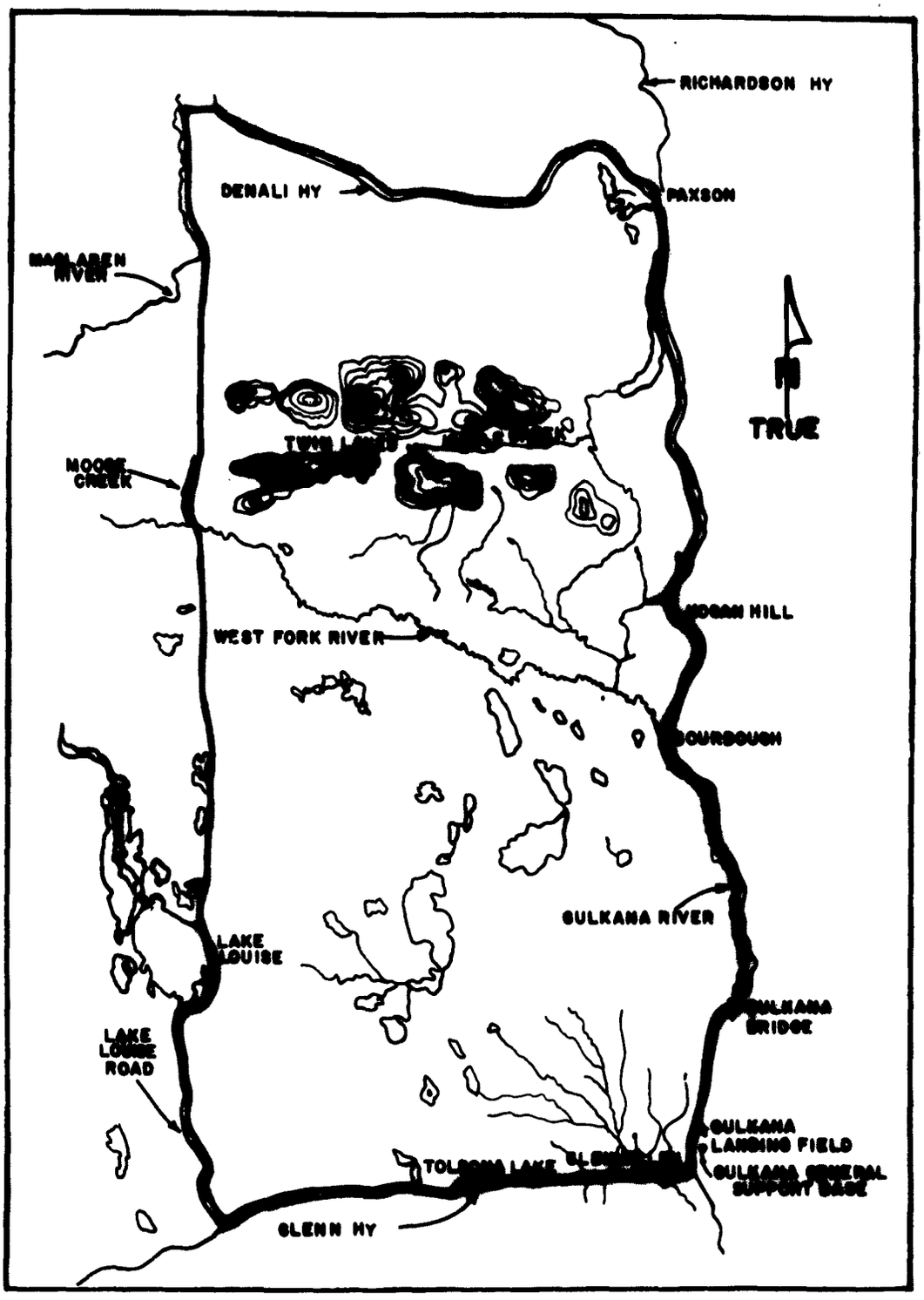

Figure 2. Details of maneuver area.

C. Personnel. The number of officers assigned was adequate. There were no critical MOS (EM) shortages; however, after USARAL assigned additional vehicles (three M8A2's and one Wagner 4-Track Transporter), the number of personnel assigned to the USATCB Task Detachment was inadequate for 24-hour operations.

D. Equipment.

1. Overland Train, Mark I (Fig. 3).

a. Background. The Overland Train was designed by U. S. Army Transportation Research Command in 1955 and delivered to the Transportation Corps in February 1956. The train, consisting of a power car and three 15-ton powered cargo trailers, was designed to operate over snow-free as well as snow-covered terrain. Engineer and service tests were conducted at Houghton, Michigan, on the Greenland Icecap, and at Fort Story, Virginia. On the Greenland Icecap, the train was operated 2,468 miles over established trails. It moved a given amount of cargo at a rate one and one-half times faster than a tracter-sled swing. The results of the tests described above were so encouraging that it was considered feasible to use the Overland Train, Mark I across country and over roads not suitable for standard wheeled vehicles as a logistical carrier in general support of a battle group during Exercise WILLOW FREEZE.

b. Principal characteristics.

	Power car	Powered cargo trailer
Length	486 in.	534 in.
Width, overall	168 in.	168 in.
Height, overall	176 in.	176 in.
Weight	58,580 lb	30,380 lb
Wheelbase	600 in.	600 in.
Turning radius	65 ft	65 ft
Ground clearance	36 in.	36 in.
Fuel capacity	500 gal.	---------
Payload	--------	30,000 lb
Speed, maximum	17 mph	---------

Figure 3. Overland Train, Mark I.

	Power car	Powered cargo trailer
Tires		
Size	48x68, 120-in diam. 10-ply	48x68, 120-in. diam, 10-ply
Pressure	10 to 12 psi	10 to 12 psi
Inflation	15 lb	15 lb
Engine		
Type	Cummins diesel VT-12	----------
Horsepower	600 at 2100 rpm	----------

c. Crew. No TOE has been established for the train although it has been type classified as standard B. A crew of six (one officer and five enlisted men) operated it during this exercise. Operating the train was the primary duty of all personnel. Additional duties included diesel-electric repair and signal operations. With this crew, the train can be operated round-the-clock. Required maintenance can be performed during operation.

d. Performance. The train was under the operational control of the general support base (GSB) located at Gulkana, Alaska. The operations plan provided for it to be employed as a cross-country logistical cargo carrier in support of a battle group.

The train arrived in USARAL during the first week of January. Because of limitations imposed by bridge dimensions and road clearances, it was unloaded and assembled at Palmer, approximately 35 miles north of Fort Richardson. It was initially planned to move the train immediately to the exercise area for a scheduled premaneuver checkout. Because of the delayed arrival of supporting tools and equipment and USARAL's plan to place all maneuver equipment on public display, the train did not leave for the maneuver area until 30 January.

Movement from Palmer to the exercise area at Gulkana--a distance of 143 miles--gave an opportunity to observe and evaluate the feasibility of moving the train over a standard, two-lane highway. The abnormal characteristics of the train made it necessary to employ an escort while traveling on the highway. The transit was successful although the height and width of the train made it necessary to bypass one small, narrow bridge.

The road was hard-surfaced; some portions were covered with ice and snow. The first 73 miles of road were characterized by inclines

not in excess of 8 percent and relatively sharp curves; the remainder was flat with only gentle, rolling slopes. The train had sufficient power and traction to make this road movement without difficulty. The average speed of the train over the highway was 8 miles per hour; fuel consumption was 1.5 miles per gallon. This performance was excellent for a cargo carrier of such size and weight.

During the initial phase of the maneuver, it was necessary for the train to break its own trail through the forest. As a result, the front section of the power car and one of the powered cargo trailers were damaged slightly.

During the latter phase, a semiprepared trail was made for the train. Terrain analysis was made by aerial and surface reconnaissance. A Weasel (M29C) was used to reconnoiter the trail ahead and expedite movement.

The carrying capacity of 15 tons per powered cargo trailer and the capability of the power car were tested to the extreme in many instances. The train successfully negotiated inclines of 50 percent and side slopes of 18 percent.

The major problem encountered with the train was punctured tires. This was the result of the type of tires used (10-ply) and operating the train over an unprepared route. Light forest, consisting mostly of scrub pine, covered approximately 75 percent of this terrain. The trees splinter when broken off and, being frozen, remain exceedingly hard--almost metallic. It is highly probable that these same broken trees would have punctured tires of more than 10 ply. This experience demonstrated that the 10-ply tires used on the Overland Train are inadequate for off-road use over the rugged terrain encountered in the Gulkana Maneuver Area.

All three tire punctures occurred on the power car of the train. Two of the tire punctures occurred simultaneously on the right rear and right front of the power car. As presently constructed, the rear wheel assemblies (a rim and tire constitute a wheel assembly) on the power car and all of the wheel assemblies on the powered cargo trailers can be changed in the field by using the jib crane mounted on the rear section of the power car. No means has been provided for lifting and changing the front wheel assembly (2, 322 pounds) in the field. This lack of a lifting device on the front section of the power car made a field expedient necessary. The front wheel assembly was changed by using chain, cables, and a 6, 000-pound forklift mounted on a Wagner 4-Track Transporter. After the simultaneous punctures on the power car, spare wheel assemblies were transported to the train from the general support base. The rims of these wheel

assemblies were a new type, designed by U. S. Army Transportation Research Command. After the right front wheel assembly was secured to the hub, it was discovered that the rim of the new wheel assembly did not provide any clearance between the tire and the frame of the power car. The original wheel assembly, installed by the manufacturer, provided a 3-inch clearance. Because of this lack of clearance, the new wheel assemblies had to be removed from the power car and exchanged for old wheel assemblies from a powered cargo trailer to prevent further tire damage. The new wheel assemblies were mounted on the powered cargo trailer and no further difficulty of this type was experienced.

When the power car is immobilized, the electrical braking system on the powered cargo trailers locks automatically and prevents the powered cargo trailers from being moved by any other prime mover unless the system is released manually. Manual release is difficult and time consuming. This characteristic could seriously affect the accomplishment of a mission.

Through past experience it was found that the wheel motors had a tendency to overheat in temperatures above +40° F. The wheel motors were closely observed on the road movement from Palmer to Gulkana and also during the exercise itself. During this period the wheel motors did not overheat.

2. Cargo Transporter, Off-Road, Large Wheel, 10-Ton, 4-Wheel, M1 (fig. 4).

a. Background. This vehicle was designed to replace tractor-drawn sleds used to transport cargo over snow-covered or other adverse terrain. Its performance on the Greenland Icecap was so satisfactory that it was decided to employ it in Exercise WILLOW FREEZE as a logistical carrier.

b. Principal characteristics.

Length, overall	474 in.
Width	
Overall	168 in.
Wheels and stub axles removed	96 in.
Height, overall	144 in.
Tires	
Size	48x68, 120-in. diam, 10-ply
Pressure	10 to 12 psi
Inflation	10 lb.

Figure 4. A 10-Ton, Off-Road Cargo Transporter, M1, and prime mover, M6A2.

Turning radius	65.5 ft
Cargo area	197 sq ft
Payload	10 tons

c. Performance. While the trailers were being positioned in the USATCB maintenance area before the exercise began, one of the units (trailer and 5-ton M52 truck tractor) jackknifed because of the icy ground. This jackknifing was not serious as the truck tractor was moving at approximately 1 mile per hour and the trailer was empty; however, the tongue of the trailer bent.

The Aggressor Forces were not able to use the two trailers allocated them because of the rugged terrain in their part of the maneuver area--the northern half. The trails were too narrow and had numerous turns which the trailers could not negotiate because of their excessive turning radius.

The U. S. Forces made only a limited use of the trailers allocated them: they used them between their direct support group and their forward units as mobile supply dumps. No trailer was towed more than 40 miles during the entire exercise. Cargo tractors (M8A2) were designated as prime movers for the trailers.

The limited use made of the trailer precluded adequate evaluation; nevertheless, it was determined that the turning radius is too great and the tongue weak.

3. Rolling Liquid Transporter, M1 (fig. 5).

a. Background. This 1,000-gallon transporter was designed to provide an economical and efficient method of transporting liquids in areas where it is not practical or possible to use conventional transportation. Exercise WILLOW FREEZE was conducted over such terrain and presented an excellent opportunity for testing the capabilities of the Rolling Liquid Transporter (RLT), M1.

b. Principal characteristics.

Length, overall	138 in.
Width, overall	98 in.
Height, overall	64 in.
Payload	1,000 gal.

Weight	
Empty	**2,240 lb**
Loaded	**8,840 lb**
Fuel cell	**64x42x18 in.**
Brakes	**Air, hydraulic**

Figure 5. Rolling Liquid Transporter, M1.

c. Performance. The U. S. Forces used their five RLT's to haul POL from their direct support group to their battle group. The prime movers used to tow the RLT's were 3/4- and 2-1/2-ton trucks. There were no mechanical failures or punctured tires. Some difficulty was experienced in the dispensing of POL because of frozen fuel lines and dispensing valves. This difficulty was the result of using personnel who did not know how to employ or operate the RLT.

The USATCB Task Detachment supporting the Aggressor Forces also had five RLT's which were used to transport POL from their

direct support group to their battle group. These vehicles were towed by Nedwell Carrier RN 110's over unimproved roads and across country. No punctures or mechanical failures occurred during the period the vehicles were being operated by the USATCB Task Detachment.

The RLT's provided an excellent means for the rapid movement of bulk fuel over adverse terrain. These transporters negotiated areas where standard wheeled vehicle tankers bogged down. Maintenance required during the maneuver was negligible and availability was 100 percent.

Vehicles were often delayed because fuel can be dispensed from only one cell at a time: there is only one set of OVM on an RLT. The feasibility of dispensing fuel from both cells simultaneously should be investigated.

4. Rolli-Trailer, 3-Ton (fig. 6).

a. Background. This trailer was assembled by combining a 3-ton cargo bed and two rolling liquid transporters (M1). It is designed to transport 2,000 gallons of bulk POL in the fuel cells and 3 tons of general cargo in the trailer bed. It is also capable of floating while transporting its rated payload of dry cargo if the fuel cells are empty.

b. Principal characteristics.

Length overall	336 in.
Width, overall	104 in.
Height, overall	102 in.
Weight	
Net	6,750 lb
Gross	25,350 lb
Wheelbase	196 in.
Brakes	Air, hydraulic
Payload	
Dry cargo	6,000 lb
POL	2,000 gal.

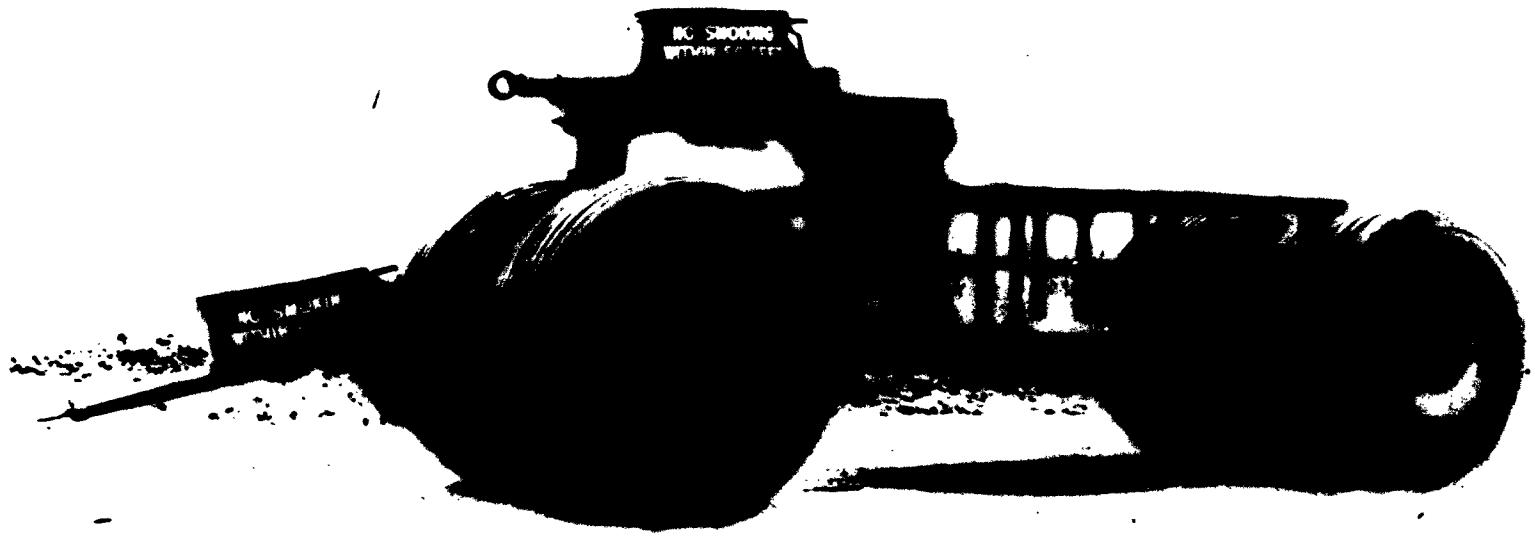

Figure 6. The 3-Ton Rolli-Trailer

c. Performance. Only one of these trailers was used during this exercise. It was allocated the Aggressor Forces. Because a suitable prime mover was not available, the trailer was used for the static storage of bulk POL for the first 5 days of the exercise. When a prime mover became available on the sixth day of the exercise, the trailer was moved forward approximately 5 miles. At this point, the tongue broke because the prime mover turned too sharply. The vehicle was deadlined during the rest of the exercise.

ANNEX A

OPERATION ORDER

C O P Y

COPY NO. _____
US Army Transportation Environmental Operations Group
Fort Eustis, Virginia
301200 December 1960

Operation Order 9 (WILLOW FREEZE, Project #EO 2270.2406-61)

Effective this date, US Army Transportation Environmental Operations Group Operation Plan (WILLOW FREEZE, Project #EO 2270.2406-61, 271400 October 1960) - Assumptions confirmed - is designated USATREOG Operation Order 9 (WILLOW FREEZE, Project #EO 2270.2406-61).

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/t/ PRETTY
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Operations Plan: E.O. 2270.2406-61 (WILLOW FREEZE) *

References:

a. Initial Maneuver Plan, Exercise Willow Freeze, dated 20 July 1960, Hqs, USARAL.
b. 1st Indorsement, TCCAD-E, Hq DAOCT, 16 June 1960 to letter, TCEOG-S3, Hq USATREOG, 17 May 1960, subject: Lease or Purchase of Commercial Items of Equipment.
c. Maps: 1:50,000 of area to be traversed, as required.

Task Organization: See Annex A.

1. SITUATION.
   a. Enemy Forces: Aggressor units provided by USARAL. See Annex B (Intelligence) to Maneuver Plan, Exercise Willow Freeze.
   b. Friendly Forces: Provided by USARAL. See Annex A (Troop List) to Maneuver Plan Exercise Willow Freeze.
   c. Attachments and Detachments: None.
   d. Assumptions:
      (1) That OCOFT will authorize USATREOG to obtain the task vehicles listed in the Bill of Materials which are necessary to accomplish the assigned mission.
      (2) That USARAL will provide logistical support outlined in Appendix 9 to Annex K, Maneuver Plan Exercise Willow Freeze.
      (3) That USATREOG equipment and personnel will be assigned to CG, USARAL and further attached to USARAL Support Command for operational control.
      (4) That unit integrity will be maintained to insure adequate testing of equipment.
      (5) That sufficient trained personnel and tow vehicles will be made available for Rolling Liquid Transporters utilization by both battle groups.
      (6) That MHE will be available at transfer points, especially that of the Overland Train.

* The annexes to this plan listing personnel, fund requirements, and bill of materials have not been included here in this copy of the operations plan.

2. MISSION. To evaluate TC equipment and doctrine to be used in logistical support of BG's operating in adverse terrain and/or northern latitudes and to further test the feasibility of off-road trailers in the role of mobile supply points, operating with independent, small units for short durations.

3. EXECUTION.

Concept of Operations:

a. Project equipment will be shipped from points of procurement or present locations to TO, USARAL Support Command, Fort Richardson, Alaska, to arrive not later than 8 Jan 1961.

b. USATREOG task element personnel will arrive at Fort Richardson, Alaska on/or about 8 Jan 1961.

c. USATREOG equipment and personnel will move to the Gulkana Support Base on order and, during the period 8-18 Feb 1961, participate in Exercise Willow Freeze for the purpose of evaluating equipment listed in sub-paragraph 4 below.

d. USATREOG equipment participating in Exercise Willow Freeze is as follows:

(1) US Forces - 187th Inf
Overland Train (1)
Off-Road Trailers (3)
Rolling Liquid Transporters (7)

(2) Aggressor Forces - 23d Inf
Nodwell Transporters (5)
Off-Road Trailers (2)
Rolli-Trailer (1)

4. ADMINISTRATION AND LOGISTICS.

a. Administration: Administrative records and support will be maintained by USATREOG.

b. Logistics:

(1) Supply: Task element OIC will accomplish supply action with G-4, USARAL.

(2) Funding: See Annex B.

(3) Evacuation and Hospitalization: USARAL, Fort Richardson, Alaska.

(4) Transportation:

(a) USATREOG personnel will travel to and from Fort Richardson, Alaska, via commercial and/or military air, to arrive not later than 8 Jan 1961.

(b) USATREOG will provide the following vehicles required for logistical support during Exercise Willow Freeze:

M29C Weasel	2
Overland Train	1
Off-Road Trailers	5
Nodwell Transporters	5
Rolling Liquid Transporters	7
Rolli-Trailer	1

5. COMMAND AND SIGNAL.

a. Signal:
Current SSI will apply.

b. Command:
(1) Overall: CO, USATREOG through Project Officer.
(2) Project Officer: As directed by CO, USATREOG.

/s/ Dawson
/t / DAWSON
Lt Col

Annex A - Personnel
Annex B - Fund Requirements
Annex C - Bill of Materials

ANNEX B

DAILY TEMPERATURE RANGE RECORDED DURING FIELD EXERCISE

These temperatures were recorded by the official weather bureau at Gulkana Airfield, Alaska. Temperatures in the maneuver area varied somewhat from these temperatures by as much as plus or minus 10° F.

Date	Temperature, Fahrenheit	
February 1961	High	Low
7	+18	+ 8
8	+18	+12
9	+18	+ 5
10	+17	-14
11	+17	-21
12	+ 5	-26
13	+ 1	-27
14	+ 5	- 9
15	+11	- 9
16	+ 9	- 2
17	+12	- 6

ANNEX C

DETAILED ACCOUNT OF PERFORMANCE OF OVERLAND TRAIN, MARK I

1. ASSEMBLING TRAIN...

a. Plan. USATCB operational plans for Exercise WILLOW FREEZE included conducting premaneuver evaluation tests of Transportation Corps equipment as soon as it arrived at the Gulkana General Support Base. These tests were intended to give the USATCB Task Detachment experience in operating their equipment in subarctic environment. Plans also provided for the Overland Train to be unloaded and assembled at Palmer, approximately 35 miles north of Fort Richardson, because of the dimensions of the bridge that spans the Knik Arm. As soon as the train was operational, it was to move from Palmer to the general support base at Gulkana via the Glenn Highway.

b. Arrival of Equipment. The disassembled Overland Train arrived in USARAL during the first week of January, but the remainder of the TC equipment and supporting items did not arrive until the fourth week of January. The special tools needed to assemble the Overland Train were in the second shipment. This delay made it necessary to borrow tools and use field expedients to assemble the train.

c. Procedure. A 50-ton crane was obtained from the Alaska Railroad and a 6,000-pound forklift was brought from Fort Richardson. Handicapped by lack of proper tools and adverse weather, the unloading and assembling of the train began on 11 January (figs. 7 through 11). The ground was rough and covered with ice and some snow: this made forklift operations very difficult. The temperature during this period was -30° F; the wind velocity was a constant 15 miles per hour.

Despite the difficult working conditions, the train was unloaded and assembled in 221 man-hours. Previously working under ideal conditions this same operation had required 200 man-hours. This 221 man-hours included 19 hours of forklift operation and 12 hours of crane operation.

On 16 January the train was operational and ready for the road movement to the general support base (GSB) at Gulkana; however, the train was not dispatched to Gulkana until 30 January. It was detained at Palmer as a part of a display of maneuver equipment made by USARAL on 30 January. As a result of this delay, premaneuver evaluation tests were not conducted.

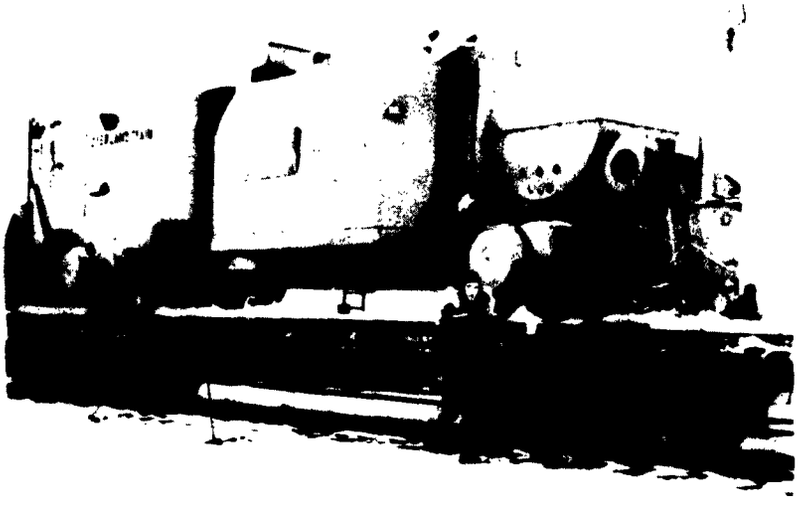

Figure 7. Preparing to unload the power car of the Overland Train at Palmer.

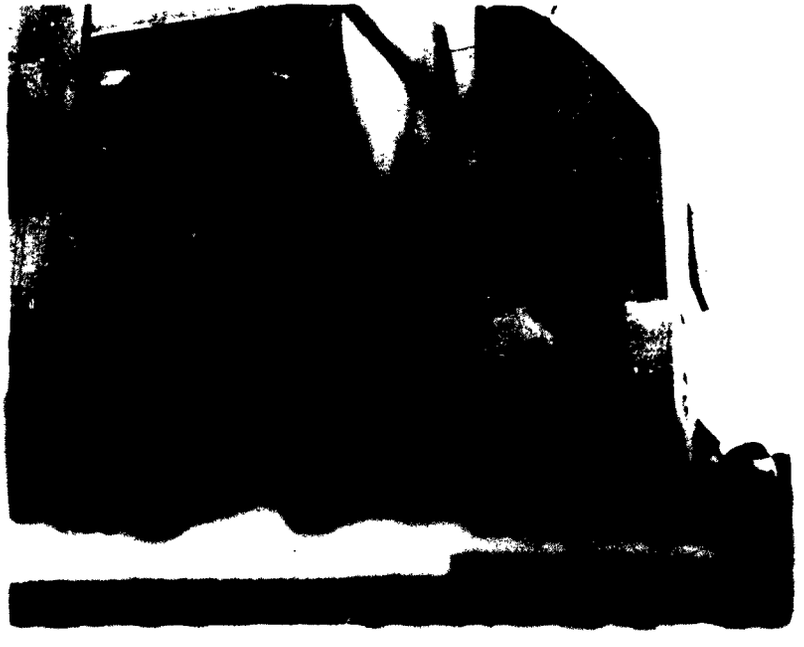

Figure 8. Inspecting power car for possible damage in transit.

Figure 9. Cutting tiedowns.

Figure 10. Placing power car on cribbing, using 50-toncrane.

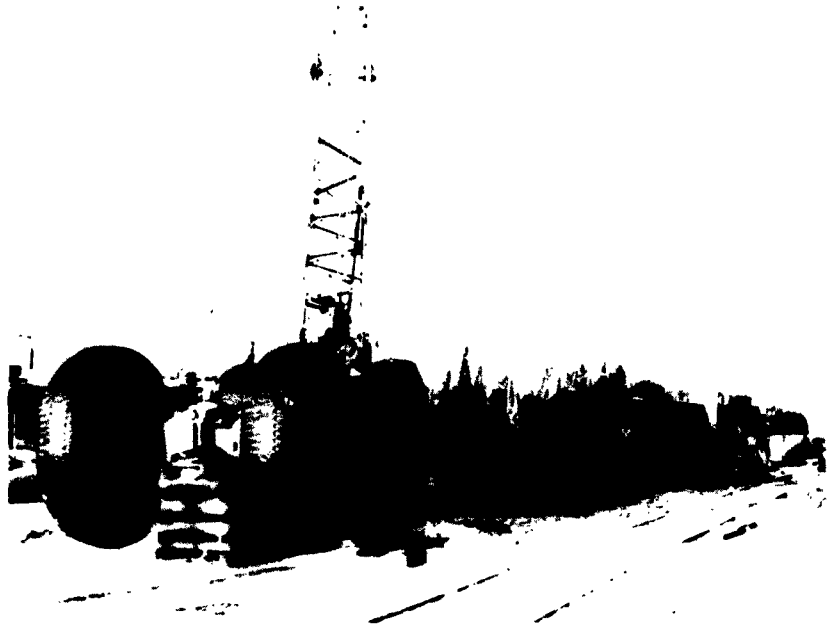

Figure 11. Assembling powered cargo trailers, securing wheels to hubs.

2. ROAD MOVEMENT TO MANEUVER AREA.

a. Description of Road. The Glenn Highway is 187 miles long, extending from Anchorage to the Glenn Highway-Richardson Highway Junction. The general support base (GSB) was located at Gulkana on the Richardson Highway, 3 miles north of this junction. Figure 12 shows the route from Palmer to Gulkana.

The Glenn Highway is an all-weather, hard-surfaced road; it is 24 feet wide and has uneven shoulders. During the winter, the snow is usually cleared for a width of 26 feet to permit two-way traffic.

Road reconnaissance made before the train began the highway movement from Palmer to the GSB, a distance of 143 miles, showed the highway was covered with ice. Unsanded "new ice," caused by water seepage running across the highway, is common and prevailed from Mile 55 to Mile 90. This condition was worse on steep grades where road cuts have been made along the mountains. The road from Palmer to Mile 120 is characterized by many sharp curves and steep grades.

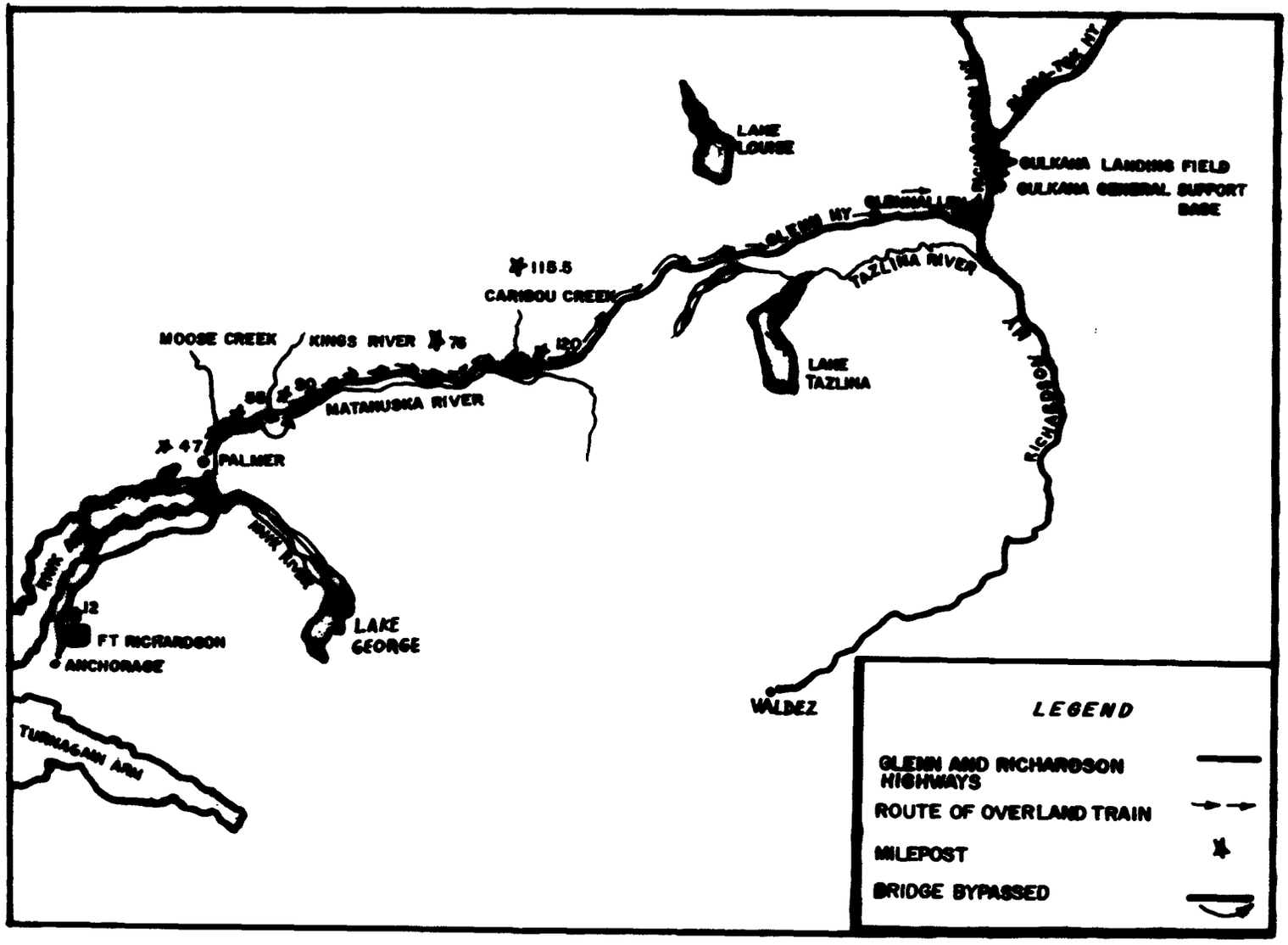

Figure 12. Route of Overland Train from Palmer to Gulkana.

The clearances of the bridges and the load capacities of both bridges and culverts along the highway were sufficient to accommodate the train with the exception of the King River Bridge at Mile 76. This bridge has a vertical clearance of 11 feet 6 inches and is 12 feet 8 inches wide which necessitated bypassing it.

b. Components of Road Movement Serial. The abnormal size of the train made it necessary to move it as an independent march unit: a unit completely separated from the remainder of the military traffic. The Overland Train march unit consisted of: one highway patrolman; two military police pilot vehicles; one 20-ton, truck-mounted crane; one 2 1/2-ton cargo truck; and the Overland Train.

c. Movement. Movement to the GSB began at 1115 hours 30 January. Immediately after leaving Palmer (Mile 47, Glenn Highway), the train began to ascend a hill that has approximately a 6 percent incline. During the ascent the engine began to overheat and subsequently cut off. The ambient temperature was -32° F. At this time the train was equipped with a suction fan which did not have a clutch thermostatic control fan hub assembly. Lack of this clutch control caused the fan to turn continuously. In an effort to regulate the temperature in the engine compartment and permit the engine to run at its proper operating temperature, a portion of the radiator had been covered. The road movement was halted while the radiator was uncovered. After the engine had cooled sufficiently, the road movement was resumed; the engine did not overheat again. The engine was left uncovered throughout the rest of the exercise. (After the exercise, a thermostatic clutch control was installed.)

The train arrived at the King River Bridge (Mile 76) on the first day of the movement at 1530 hours. The bridge was bypassed by crossing the frozen river where it was 35 yards wide. The banks of the river were even and gentle; the bypass was made without difficulty or engineer preparation.

The road from Mile 55 to Mile 90 is characterized by some hills, curves, and a few side slopes. As a result of this and the iced condition of the road, it was believed the train would have a tendency to slide; however, the train passed over this section of the road with no trouble.

It was also believed that it would be difficult to traverse the area around Caribou Creek. The road descends rather sharply for approximately 1.5 miles to the Caribou Creek Bridge (Mile 115.5) where it abruptly begins ascending until it levels off at Mile 118. In this area the road was completely covered with ice. Although the entire hill had been sanded, the crew of the train was apprehensive. Again much to the surprise of everyone, the train crossed this area without trouble.

The remainder of the road to the GSB was relatively flat, and the train continued its movement to the GSB without difficulty.

3. OPERATION IN SUPPORT OF U. S. FORCES.

a. Mission. On 9 February the train was loaded with approximately 25 tons of ammunition and 5 tons of rations. This was designated as the U. S. Forces' basic load and was due at their direct support group (DSG) within 24 hours after the exercise began. (The exercise began 10 February.) Orders provided for this cargo to be moved to the DSG, approximately 18 miles, by the most direct overland route. An aerial reconnaissance was made; then a short surface reconnaissance was made in an M29C Weasel. A route was selected along an old tractor trace. The aerial reconnaissance showed that this was the only feasible cross-country route in the entire south portion of the maneuver area.

b. Procedure. On 10 February, the train left the GSB and started to move along the tractor trace, which was approximately 8 feet wide; no trail was prepared. The trace ran west through a dense forest in which the trees were 4 to 6 inches in diameter and less than 10 feet apart. The train moved over this route, knocking down trees continuously (figs. 13, 14, and 15). When trees were knocked over by the wheels of the train, stumps, usually 6 to 8 inches high, were left (fig. 16). These stumps often damaged the tires, either cutting or puncturing them (fig. 17). The chassis of one of the powered cargo trailers was damaged by the trunk of a tree becoming lodged between a wheel and the bed: the circumference of the tree, 1 foot above its roots, was 47 inches (fig. 18). The train averaged approximately 1 mile per hour while traversing this extremely difficult terrain.

c. Difficulties Encountered.

(1) Punctured tires. The train moved along the tractor trace for approximately 3 miles before the two tires on the right side of the power car were punctured simultaneously. The right front tire was punctured by a stump of undetermined size; the right rear tire was punctured by a sharp piece of frozen birch, about 2 inches in diameter, which completely penetrated the tire. The right front tire was severely damaged by the puncture, an 8-inch break developed all the way through the tire; this puncture made it necessary to change the right front wheel assembly. (A wheel assembly consists of a rim and tire.) Although the frozen birch stump completely penetrated the right rear tire, the hole in the tire was small and could have been repaired temporarily if a tire repair kit had been available. Lack of a tire repair kit necessitated changing the rear wheel assembly too.

All spare wheel assemblies were stored at the GSB: no provision has been made for the train to carry a spare wheel assembly.

Figure 13. Overland Train moving over tractor trace.

Figure 14. Power car pushing over scrub trees.

Figure 15. Side view of powered cargo trailer traversing tractor trace.

Figure 16. Two trees, approximately 4 inches in diameter knocked over by right front wheel of power car.

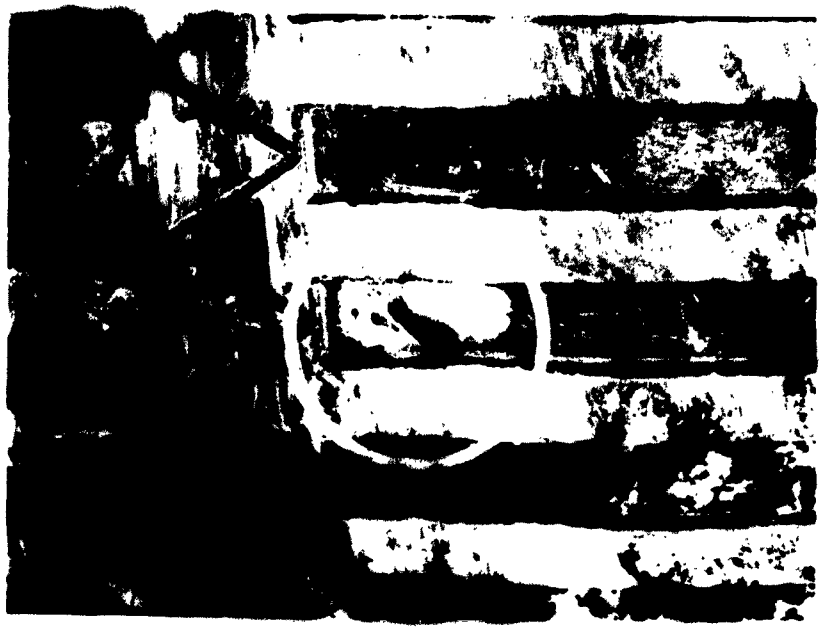

Figure 17. Tire damaged by tree stump.

Figure 18. Large tree uprooted by powered cargo trailer.

Tools, spare wheel assemblies, and other equipment required to make the repair were transported to the train from the GSB by another test vehicle (Wagner 4-Track Transporter). Since there is no lifting device on the front of the train to facilitate changing the front wheel assembly (2, 322 pounds) in the field, a field expedient was devised. A second trip was made to the GSB by the Wagner 4-Track Transporter to get a 6, 000-pound forklift to lift the front of the power car. This field expedient is explained below.

(2) Changing wheel assemblies. Changing the rear wheel assembly was not difficult and was accomplished in approximately 3 hours. A 20-ton railroad jack was used to lift the rear wheel assembly. The jib crane installed on the rear section of the power car was used to remove the wheel assembly with the punctured tire and also to mount a spare wheel assembly.

Changing the right front wheel assembly proved to be quite difficult. Facing aft, the 6, 000-pound forklift was secured to the trailer bed of the Wagner 4-Track Transporter with chains, and cables were attached to the forks (fig. 19). The right front axle of the power car was

Figure 19. Forklift secured on Wagner Transporter.

raised by using a 20-ton railroad jack. The Wagner 4-Track Transporter was positioned so as to place the forks immediately above the wheel assembly. The wheel assembly was secured to the forks with a sling. With the lift capability of the forklift and a backward and forward movement of the Wagner 4-Track Transporter, the wheel was removed from the hub. The spare wheel assembly was put on the hub by following basically the same procedure as just described. It took 8 hours to make this repair. The temperature averaged -20° F.

(3) Jamming of wheel assembly. When the exercise began, the train was equipped with wheel assemblies installed by the manufacturer. The spare wheel assemblies all had a new type rim that was designed by the United States Army Transportation Research Command. After the spare assembly had been secured to the right front hub of the power car, it was found that there was no clearance between the frame of the power car and the tire (fig. 20). The original wheel assembly allowed a 3-inch clearance (fig. 21). Since it was obvious that none of the spare wheel assemblies would give the necessary clearance, one of the original wheel assemblies was removed from a powered cargo trailer and mounted on the front hub of the power car and the spare (new) wheel assembly was installed on the powered cargo trailer. Later at the base camp, it was discovered that the tire of the other new wheel assembly which had been installed on the right rear of the power car was also rubbing against the frame of the power car. Continued operation of the train with the wheel in this condition would have resulted in severe damage to the tire. Because of this condition, wheel assemblies were again exchanged between the power car and a powered cargo trailer. This exchange was made by using a 5-ton wrecker (M62). The new wheel assemblies performed satisfactorily when mounted on the powered cargo trailer.

d. Return to General Support Base. The tire punctures and ensuing difficulties which resulted from operating the train over heavily forested terrain without a prepared trail proved that it was virtually impossible to operate the train over the old tractor trace. Consequently the crew and train were ordered to return to the GSB.

4. OPERATION IN SUPPORT OF AGGRESSOR FORCES.

a. Situation. Since operation of the train in support of the U. S. Forces, located in the southern part of the maneuver area, proved most unsuccessful, it was decided to use the train to provide logistical support to the Aggressor Forces who were in the northern part of the maneuver area. The fact that the Aggressor Forces had moved south more rapidly than had been anticipated made it necessary to establish a main supply route (MSR) about halfway between the GSB and the Aggressor DSG. The route was reconnoitered and an MSR was selected. It ran from the GSB 43 miles north over

Figure 20. New wheel assembly mounted on right front hub of power car, showing lack of clearance between frame of power car and tire.

Figure 21. Original wheel assembly, showing 3-inch clearance between frame of power car and tire.

the Richardson Highway to Mile 160 and then 15 miles west across country to intersect the Aggressor Forces' route. It was planned to prepare an overland trail along the 15-mile, cross-country part of the MSR with bulldozers. This situation presented an opportunity to operate the train across country over a semiprepared trail. Furthermore a heavy snowfall in this area increased the likelihood of a successful operation of the train.

b. Mission. The new mission of the train was to provide logistical support between the Gulkana General Support Base and the Aggressor Forces' battle group by transporting supplies over the MSR described above.

c. Procedure.

(1) Initial movement of the train. On 13 February the train was checked out mechanically; then loaded with 30 tons of POL and 10 tons of rations. The following day, it proceeded along the Richardson Highway to Mile 160. Upon arriving at this point, it was necessary to wait for the engineers to prepare the cross-country trail into the maneuver area. The next morning, the train resumed its movement along the semiprepared trail which was in very good condition and posed no problems (fig. 22). The train averaged from 3 to 5 miles per hour without difficulty. Care was taken to be sure the trail was clear and there was no danger of the tires being punctured.

Figure 22. Semiprepared trail in northern part of maneuver area.

(2) River crossing. The train continued to move along this semiprepared trail for approximately 5.5 miles before it reached the Gulkana River where an ice bridge had to be constructed (fig. 23). At the crossing site, the river was 200 feet wide and 4 feet deep. The trail across the frozen river was laid out at a 90° angle. The 23-inch depth of the ice on the river was not considered strong enough to support the train. A 16-inch ice bridge was added; this total depth of 39 inches provided sufficient bearing capacity for the train. Using this ice bridge (fig. 24), the train successfully crossed the Gulkana River on the morning of 16 February and continued its movement along the semiprepared trail for another 4 miles. Because one bulldozer broke down and another became immobilized in the muskeg, the engineers were unable to prepare the trail any farther.

Figure 23. Building ice bridge over Gulkana River.

d. Difficulties Encountered.

(1) Jackknifing of train. On the morning of 17 February, the train's crew was instructed to continue the movement across country without the assistance of the engineers. Breaking its own trail, the train resumed moving over extremely adverse terrain toward the Aggressor battle group

Figure 24. Overland Train crossing the Gulkana River, using the ice bridge.

(fig. 25). The train proceeded for approximately 2.5 miles without much difficulty. The route followed was reconnoitered by foot to try to avoid tire punctures. After traveling this 2.5 miles over an unprepared trail, the train encountered a slope about 500 yards long with an approximate 50 percent incline. A slight left turn was made preparatory to attempting to traverse the slope. This slight turn caused the powered cargo trailers to jackknife. The powered cargo trailers were realined with the power car by cutting off the power from the powered cargo trailers and moving the power car forward. After this realinement had been accomplished, the train negotiated the hill without further difficulty. The adequacy of the train's power and traction was proved by its successful ascent of this slope (fig. 26). In addition to breaking its own trail through the scrub forest, it moved through 2 to 3 feet of snow.

(2) Tire puncture (figs. 27 and 28). After traveling another mile through a relatively thick growth of scrub pine, it was noted that the first powered cargo trailer was tracking out of line. Investigation showed that the tire on the left rear wheel of the power car has been punctured. A spare wheel assembly had to be brought by truck from the GSB to Mile 160 on the Richardson Highway. At Mile 160, the assembly was transferred

Figure 25. Typical terrain traversed by Overland Train while breaking its own trail.

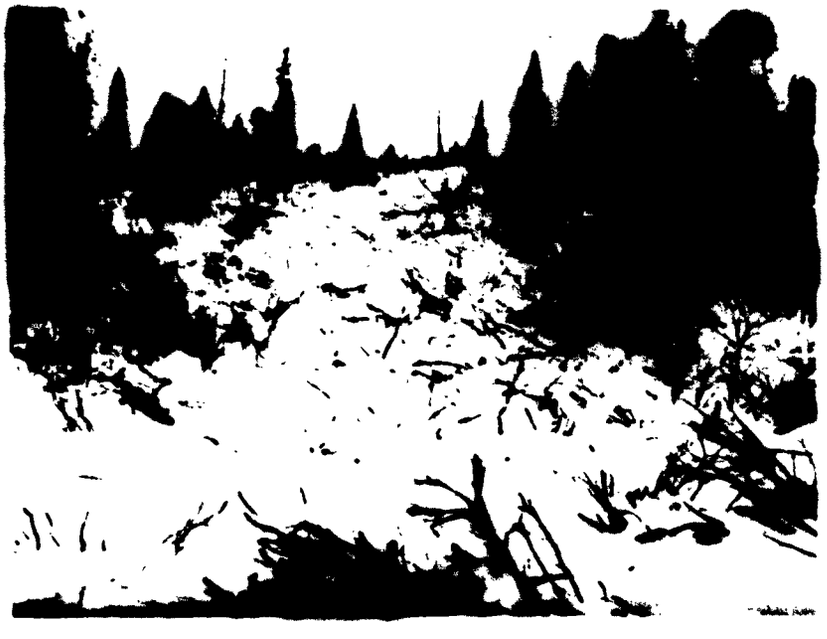

Figure 26. Steep slope negotiated by the Overland Train.

from the truck to a Nodwell Carrier RN 110 which hauled it to the train. While this was being done, it was discovered that a 5-ton wrecker (M62) was in the area. The wrecker was pulled to the train site by a D-8 tractor to provide the lift capability needed to change the wheel assembly. While the wheel assembly and wrecker were being brought to the train site, the punctured tire was being prepared for removal. It took only 3 hours to change this wheel assembly: no difficulties developed.

Figure 27. Rear view of a punctured tire of power car.

e. Conclusion of Exercise. Exercise WILLOW FREEZE ended while this repair was being made so the crew was instructed to return the train to Mile 160 on the Richardson Highway. The return move to Mile 160 was made without any difficulty or delay.

5. FINDINGS.

a. Capabilities.

(1) Mobility.

(a) Across-country. With a semiprepared trail, the train can traverse terrain, at an average speed of 5 miles per hour, that

Figure 28. Side view of punctured tire.

standard wheeled vehicles cannot negotiate. With this rate of speed, the train can equal the mobility of a supported unit.

(b) Highway. The train can move to any preselected area over the highway with little difficulty. During the 143-mile movement over the Glenn Highway from Palmer to the Gulkana General Support Base, it averaged 8 miles per hour. It was able to cross all bridges on the route except one which was too narrow. The bypassing of this narrow bridge was accomplished without difficulty, delay, or engineer preparation. At no time was traffic on the highway delayed by the train. The train has an invaluable capability as a logistical cargo carrier because it does not, as other cargo carriers, have to be transported or convoyed.

(2) Power and traction. During the maneuver the power capability of the train was tested to the extreme. It was repeatedly demonstrated that the train had sufficient power and traction to traverse the inclines and slopes encountered. It negotiated inclines of 50 percent and side slopes of 18 percent. At one time it negotiated a 50 percent incline while breaking its own trail through snow 2 to 3 feet deep.

(3) Powered cargo trailer capacity. The 15-ton powered cargo trailers proved capable of hauling the rated payload across country under very adverse conditions.

(4) Suitability as cross-country logistical support vehicle. With a semiprepared trail, the train is capable of moving a tremendous amount of cargo across country over adverse terrain 24 hours a day. Its speed, maneuverability, and mobility make it a suitable logistical support vehicle for a unit operating across country.

b. Problems.

(1) Power car.

(a) Changing wheel assembly. The power car has a jib crane on the rear section to help in the loading and unloading of cargo. This crane can also be used to facilitate the changing of the rear wheel assemblies. There is no lifting device on the front section of the power car; consequently, it is necessary to resort to a field expedient to change the front wheel assembly. A lifting device should be installed on the front section of the power car to facilitate changing the front wheel assembly in the field.

(b) Bumper. The bumper is not designed so as to adequately protect the front wheels from being damaged by underbrush. The bumper should extend beyond the front wheels to prevent trees that are pushed over from falling against the front section of the power car or between the wheels and the side of the power car. The bumper should also extend downward far enough to break off small brush and stumps evenly with the ground to help prevent tire punctures.

(2) Powered cargo trailer.

(a) Braking system. The powered cargo trailers are equipped with an electric braking system. When the current is shut off or the power car is immobilized, the brakes lock automatically, making it impossible to move the powered cargo trailers with another prime mover unless the brakes are released manually. Manual release of the brakes is tedious and takes approximately 2 hours. An easier method of releasing the brakes is needed.

(b) Chassis. The powered cargo trailers are not constructed to withstand operation across country except over a semiprepared trail. Consequently, cross-country operation in the maneuver area over unprepared trails subjected the chassis of the powered cargo trailers to severe beating by heavy brush and trees (fig. 29).

Figure 29. Front section of cargo bed of powered cargo trailer, showing damaged chassis.

(c) Sides and side racks. The sides and side racks of the powered cargo trailers were also damaged as a result of being moved through wooded areas without a semiprepared trail (fig. 30). Guard rails for the side-rack wells were installed just before this exercise; they proved very satisfactory. Without these guard rails, it is probable that the dense brush would have torn the sides of the powered cargo trailers out.

(3) Tires.

(a) Fabrication. The 10-ply tires installed on the train were not fabricated to withstand operations over such terrain as that encountered in the maneuver area. Three tires on the power car were punctured by frozen stumps during the exercise. The side walls of other tires were damaged by being run or jammed against frozen trees or stumps (fig. 31). It is probable that tires of even heavier construction would have been damaged in this operation. Heavier-ply, metal-reinforced tires would probably be less susceptible to puncture.

(b) Availability. A great deal of time was lost because a spare wheel assembly was not immediately available in the field. It is

Figure 30. Damaged side racks on left side of powered cargo trailer.

Figure 31. Side wall of tire damaged by a frozen stump.

essential that a spare wheel assembly be carried on the train. Since transporting a wheel assembly in a powered cargo trailer would result in the loss of valuable cargo space, the train should be equipped with a spare wheel assembly rack. The rack should be designed so as not to increase the overall height or width of the train.

(c) Tire repair kit. On-vehicle materiel should include a tire repair kit. Small punctures could be temporarily repaired in the field without removing the wheel assembly or separating the tire from the rim.

(4) Need for mobile service unit. The usefulness and availability of the Overland Train, or any large off-road vehicle, would be greatly increased if a compatible mobile service unit were developed and produced. The service unit should be equipped with a crane having a 7- to 8-ton lifting capacity at a 10-foot radius and a blade capable of preparing a trail suitable for any large off-road vehicle or train. Such a service unit would make field maintenance immediately available.

ANNEX D

REFERENCES

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Final Report, Exercise WILLOW FREEZE, Headquarters, U. S. Army, Alaska, 1961

Final Report, Nodwell Carrier, RN 110, Phase I: Subarctic Evaluation, 1961, U. S. Army Transportation Board, Fort Eustis, Va.

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USAES	(1)	JUSMMAT	(1)	SUPFANT	(1)
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USATSCH	(1)	USACMLCPG	(1)	LFDEVCTR	(1)
USAWC	(1)	USACMLCTR	(1)	USAF-AIR RD COMD	(1)
AFSC	(1)	USACMLERDL	(1)	AIR PG CTR	(1)
NWC	(1)	CE-COE	(2)	AIR UNIV LIB	(1)
TAGBDUSA	(1)	USAERDL	(2)	13th AF Wea Det	(1)
USAMSBD	(1)	USACRREL	(1)	MISC	
USACMLCBD	(1)	USAPRDC	(1)	ASD (RD)	(1)
USAEBD	(1)	WES	(1)	ACSI	(1)
USAMPBD	(1)	MC-TSG	(1)	DCSOPS	(1)
USAORDBD	(1)	ORDC-CofOrd	(1)	DCSLOG	(1)
USAQMBD	(1)	OTAC	(4)	CRD	(2)
USASCBD	(1)	APG	(1)	SECINT	(1)
USASABD	(1)	USAOMC	(1)	ARO	(2)
USAMAINTBD	(1)	QMC-TQMG	(1)	ASTIA	(10)
USARONE	(2)	QMRECOMD	(2)	GPO	(1)
USARTWO	(2)	QMFEVA	(1)	Lib of Congress	(4)
USARTHREE	(2)	SigC-CSigO	(1)	ORO	(1)
USARFOUR	(2)			DCOMM	(1)
USARFIVE	(2)				

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U. S. Army Transportation Board
Fort Eustis, Virginia

WILLOW FREEZE

Project No. TCB-61-045-EO

October 1961, _____pp, illus.

UNCLASSIFIED

Exercise WILLOW FREEZE was a semi-controlled maneuver conducted by the
(over)

1. Off-road equipment--subarctic wintertime operational evaluation
2. Transportation-subarctic wintertime operations

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Overland Train, Mark I
Cargo Transporter, Off-Road, Large Wheel, 10-Ton, 4-Wheel, M1
Transporter, Liquid, Rolling Wheel Type, 1,000-Gallon, M1
Rolli-Trailer

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